# Integrated Storm Shutter

## BACKGROUND OF THE INVENTION

[0001] This invention relates generally to window and other building portal protection and, more specifically, to methods and apparatus for protecting windows and other building portals against wind, airborne moving objects, and other conditions likely to cause damage to the portal structure or, upon entry, to an interior of the building.

[0002] A variety of structures for shutters, for houses, apartments, motels, hotels and other commercial buildings are known in the building arts. Shutters may be, but are typically not installed for permanent or semi-permanent coverage over their associated portal. More typically, shutters are selectively movable and securable into open and shut modes using, for example, a hinge and latch mechanism.

[0003] Examples of known shutter types include rolling shutters, accordion shutters, removable and stowable panels, "Bahama" shutters, and "Colonial" shutters.

[0004] Rolling shutters, or roll shutters, include a plurality of parallel abutting slats, hinged to one another or attached at their respective ends to flexible support strips. A coiling mechanism selectively winds the slats into a bundle above the window, and unwinds them such that they collectively cover the window. Rolling shutters offer substantial protection but have shortcomings, such as blocking the view and the airflow through the portal when they are closed, that makes them undesirable for many applications.

[0005] Accordion shutters generally comprise an assembly of hinged, interlocking aluminum or steel blades that move horizontally between an upper and lower track. The blades are substantially abutting and parallel to one another when the assembly is extended across the window, and fold into a stack, accordion-style, when the assembly is moved to its open position. For larger areas there are two blade assemblies, that meet in the

middle of the window portal when closed, and which moves toward the right and left, respectively, to assume an open position.

[0006] Removable and stowable panels are typically a low-cost, effective protection. Variations include plywood that is nailed or bolted to the building exterior, and corrugated metal covers that fit into tracks that are permanently installed above and beneath the windows. Although simple and relatively low cost, these typically require considerable manual effort to install and remove, and require substantial, accessible storage space.

[0007] "Bahama" and "Colonial" style shutters are respective styles of louvered shutter assemblies that are hinged to swing open and shut over a window or other portal. The Bahama style is a single panel shutter, the panel having a slightly larger area than that of its associated window. The top of the shutter is attached to a hinge mechanism having a pivot axis above the window opening. The shutter is supported in its open position by two removable struts, at an angle of approximately 45 degrees. The shutter is closed to serve as a window protection by removing the two rods, allowing the shutter to lie flat against the building and over the window. A sliding pin then locks it. The Colonial style is a two-panel shutter, each panel attached to a hinge extending vertically at either side of the window. The shutters are moved to their open position by swinging each outward until it lies flat against the building, one at each side of the window. The shutters are closed by folding each inward until each is flat over its half of the window. A latch holds the shutter panels in their closed position.

[0008] The outer frame of the Bahama shutters, and of each of the two halves of the Colonial shutter, is typically formed of four abutting members, screwed or welded together at the respective ends. U.S. Patent No. 5,907,929, at FIGS. 2 and 6, depicts an example of a screwed-together abutting end.

[0009] The present inventors have identified that although the known types and examples of shutters may provide certain forms of protection for windows and portals, a need exists for reduced weight, increased strength, extended life, and ease of installation and operation.

[0010] For example, the screw connection of the rails of the Bahama shutters depicted by U.S. Patent. No. 5,907,929 may fail due to environmental conditions such as, for example, repeated wind-induced flexing of the shutter and its peripheral rails. Similarly, welded butt joints at the corners of the shutter frame have a probability of failing, due to repeated flexing of the joints or to defects in the original weld quality.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a front projection view of a first example shutter, showing the unitary perimeter frame supporting a plurality of louvers.

[0012] FIG. 2 is a perspective partial cut-away view of the FIG. 1 example shutter;

[0013] FIG. 3 is an exploded view of an enlargement of the region 3 of FIG. 1;

[0014] FIG. 4 is a top projection view of the example corner connection member shown in FIG. 3;

[0015] FIG. 5 shows a cross-section of the FIG. 3 and FIG. 4 example rail engagement members, as seen from the 5-5 cut-line of FIG. 4;

[0016] FIG. 6 shows an example cross-section of the perimeter rails of the FIG. 1 unitary perimeter frame, viewed from the 6-6 projection of FIG. 2;

[0017] FIG. 7 shows a cross-section of example louver-support rails supported by the perimeter rails according to FIG. 6;

[0018] FIG. 8 is a cross-sectional view of an example louver;

[0019] FIG. 9 is a cut-away front view of a latch mechanism that utilizes one of the corner connection members as a latch supporting guide;

[0020] FIG. 10 is a perspective view of an example latch pin receiver for receiving the latch pin of the FIG. 9 example;

[0021] FIG. 11 is a front projection of another described shutter, having a center support member;

[0022] FIG. 12 shows the FIG. 11 shutter with its upper perimeter rail removed, and a center lateral securing member suspended above its insertion position;

[0023] FIG. 13 shows a perspective view of the I-frame of the center louver-support member of the FIG. 11 shutter;

[0024] FIG. 14 shows the end view of the FIG. 13 I-frame, having left center louver support rail and right center louver support rail inserted;

[0025] FIG. 15 shows the shutter of FIG. 11 with its upper perimeter rail suspended above its assembly position;

[0026] FIG. 16 is a partial cut-away of the top perimeter rail member, in its assembled position;

[0027] FIG. 17 is an example perimeter rail including a hinge structure; and

[0028] FIG. 18 shows another example hinge structure for attachment to one of the perimeter rails.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

### The Overview

[0029] The described structures are referenced as "shutters," but the term is only for purposes of identifying their general function, and does not limit the described structures to being mounted to a building using a hinge mechanism.

[0030] Objectives of the described shutters include durable, easy-to-manufacture, economical and selectively aesthetic protection of windows and other building portals against forces including those exerted by hurricanes, as well as other forces, both natural and man-made.

[0031] A first example of the described shutters includes a unitary perimeter frame, preferably formed of four longitudinal rail members and four corner supporting members, interlocked and bonded into an integrated, unitary structure. The unitary perimeter frame supports a portal protective structure such as, for example, a plurality of louvers or slats.

[0032] In the first example, each of the four corner connection members includes a pair of rail engagement members. Each of the longitudinal rail members includes at each of its distal ends a corner support receiving structure, an example being a channel or receptacle, for receiving one of the pair of rail engagement members. The pair of rail engagement

structures of each corner connection member, and the receiving structures formed in the longitudinal rails, are constructed and arranged such that each corner connection member secures and supports two longitudinal rail members to form two adjacent sides of, for example, a rectangle, with the corner connection member located at the vertex. The rail engagement structures of the corner connection member project into, and are preferably adhered to the receiving structures of the longitudinal rail members, thereby forming a unitary frame.

[0033] An example portal covering for this first example shutter is a plurality of slats, or louvers, supported by the unitary perimeter frame. It will be understood that the term "louver," as used herein, encompasses all of its ordinary and customary meanings in the construction and home building arts, as well as any slat, or plurality of slats, or other structure supportable by the peripheral frame to extend across a window or other portal. The louvers can have any cross section, including, but not limited to, rectangular, oval, circular, and square, and can be either solid or hollow.

[0034] In one example arrangement the louvers are supported to lie parallel to one another, substantially within a common plane. In this example, each of the louvers has a first distal end and a second distal end, and extends a length between the two ends substantially equal to the spacing between two opposite facing longitudinal rails. The first distal end is supported by one of the two opposite facing longitudinal rail members, and the second distal end is supported by the other of the two opposite facing longitudinal rail members.

[0035] Particular structures and methods for the unitary perimeter frame to support the plurality of louvers are described.

[0036] Another example structure includes a center louver-support member.

[0037] Another example of the described shutters has a latch guide structure included in the perimeter frame, a slidable latch member supported by the latch guide structure, and a receiving structure secured to an external window frame structure adjacent to the perimeter frame.

Detailed Description

[0038] FIG. 1 is a front projection view of a first example shutter, labeled generally as 10, formed of unitary perimeter frame 12 supporting a plurality of louvers 14. FIG. 2 is a perspective view of the FIG. 1 example shutter 10, having a portion of the unitary perimeter frame 12 partially cut-away to show inner structure, as described further below. FIG. 3 is an exploded view of region 3 of FIG. 1, further depicting the structure of unitary frame 12, as well as its example structure for supporting louvers 14.

[0039] Referring to FIGS. 1 and 2, unitary perimeter frame 12 is a permanently bonded unit formed of four perimeter rail members, 16, 18, 20 and 22, and four corner connection members. The four corner connection members are labeled generically as 24, and one of these is visible in the FIG. 2 cut-away view and the FIG. 3 exploded view. In the depicted example, the four perimeter rail members comprise upper perimeter rail member 16, lower perimeter rail member 18, left perimeter rail member 20, and right perimeter rail member 22. It will be understood that the terms "upper," "lower," "left" and "right" are not absolutes and are used only for purposes of having a reference direction within the figures. More particularly, it will be understood that shutter 10 can be constructed such that the extending direction of the louvers 14 is parallel to, or vertical to the ground plane of the building (not shown in FIG. 1) onto which shutter 10 is attached. Further, as will be described in greater detail below, a shutter in accordance with item 10 can be constructed with a hinge, for a pivoting attachment to a building, having a pivot axis along any of the four peripheral rail members 16, 18, 20 and 22.

[0040] The preferable material for the perimeter rail members 16, 18, 20 and 22 is a lightweight, strong, workable material such as, for example, T6 aluminum alloy. The corner connection members 24 are preferably formed of a high strength, non-brittle, lightweight, and readily drillable material to which adhesives such as, for example, urethane can securely bond. An example is nylon.

[0041] It will be understood that the example shutter 10 is described as having its four peripheral rail members 16, 18, 20 and 22 cut from the same extruded stock, and therefore each having the same cross-section. Likewise, for the present example shutter 10, all four of the corner connection members 24 are identical to one another. Therefore, for this example, the cooperative structure, and configuration by which each of the corner connection members 24 joins distal ends of two of the perimeter rails at the four vertices of the shutter 10, unless otherwise stated, can be understood from the description below in reference to lower right region 3 of FIG. 1.

[0042] FIG. 4 is a top projection view of the example corner connection member 24, showing it as an L-shaped structure having two rail engagement members 24A extending approximately 90 degrees in relation to one another, from a common juncture 24B. FIG. 5 shows an end view of the FIG. 3 and 4 example rail engagement members 24A. Referring to FIGS. 4 and 5, each rail engagement member 24A has a plurality of longitudinal grooves 24C, separated by plurality of lands 24D. The grooves and lands are shown in the depicted example for reasons described further below, but may be omitted if desired. A taper 24E at the distal ends of the rail engagement members 24A is preferred, for ease of insertion into the channels 26 at time of assembly.

[0043] Each of the four peripheral rail members 16, 18, 20 and 22 has, at each of its opposing distal ends a channel, each being in accordance with channel 26 visible at the right distal end of lower perimeter rail member 18 in FIGS. 2 and 3. The channels, referenced generically as 26, each extend inward from the distal end of the perimeter rail member a length sufficient to receive a rail engagement member 24A. In the depicted example, perimeter rails 16, 18, 20, and 22 are extruded and, therefore, the channels 26 are actually respective end portions of a channel that extends the entire length of the rail.

[0044] FIG. 6 shows an example cross-section of the perimeter rails 16, 18, 20 and 22, viewed from the 6-6 projection of FIG. 2, depicting an example channel 26 that receives rail engagement members 24A. Referring to FIGS. 5 and 6 together, it is seen that the cross-section of

channel 26 is configured to accommodate the rail engagement member 24A. More particularly, referring to FIG. 6, the example channel 26 has a plurality of first ridges 26A on its side inner surfaces and a plurality of second ridges 26B on its upper and lower inner surfaces. The first ridges 26A contact corresponding lands 24D on two opposite parallel sides of rail engagement member 24A, and the second ridges 26B contact corresponding lands 24D on the other opposite parallel sides of 24A. The spacing between adjacent first ridges 26A, and the spacing between adjacent second ridges 26B, is such that these align with the lands 24D on the rail engagement members 24A.

**[0045]** With continuing reference to FIG. 5, the first ridges 26A on the two side opposing and the second ridges 26B on the upper and lower surfaces are spaced with respect to the outer dimensions of the rail engagement members 24A, preferably to form a reasonable, for example, slight interference fit, when these structures are inserted into the channels 26. A slight interference fit may be preferable, as any clearance between the channel 26 and the rail engagement member 24A may allow flexing of unitary perimeter frame 12 that, over time, may decrease the operational life of the shutter. The degree of interference fit, if any, between the ridges 26a and 26b, and the lands 24d of the rail engagement member 24A, is based on the desired insertion force at time of manufacture. This in turn is based, in part, on the dimensions of the actual product, and the material of which the corner connection member is formed. This is readily identified, upon reading this description, by persons of ordinary skill in the industrial arts pertaining to shutter manufacture.

**[0046]** The ridges 26A and 26B on the channel 26, and the grooves 24C and lands 24D are not essential for the structures contemplated in accordance with this description. As will be further understood from the example assembly process described below, grooves and lands such as structures 24C and 24D formed in the rail engagement members 24A may better facilitate the insertion, application and distribution of adhesives. Similarly, ridges 26A and 26B are contemplated as allowing a slight interference fit between the ridges 26B and the rail engagement member

24A, or the lands 24D, without incurring binding or requiring excessive force for assembly.

**[0047]** Referring to the FIG. 1 example, as further depicted by FIG. 2, the distal ends of each of the perimeter rail members have a mitered surface 30, each being, for example, 45 degrees with respect to the longitudinal axis of the rail member. The 45-degree mitering provides for the peripheral rail members to completely, or at least substantially cover the inner connection members 24 after the assembly into the unitary perimeter frame 12 of FIG. 1.

**[0048]** Referring to FIGS. 3 and 6, upper perimeter rail member 16 has a cross-section defining channel 26 and a guide channel 34. The depicted guide channel is U-shaped having a pair of opposing abutment ridges 34A on lateral parallel walls extending away from a bottom surface 34B. The left and right perimeter rails members 20 and 22, since they have the same cross-section as rail 16, have the same U-shaped guide channel as 34 of the upper rail 16. A primary purpose of the guide channel 34 is to secure the louver supporting rails 36A and 36B, described below, to the left and right rails 20 and 22. The upper and lower perimeter rails 16 and 18, for this example, do not require a louver-supporting structure. However, in the depicted example, all of the perimeter rail members 14, 16, 18 and 20 have the same cross-section. As described above, this allows all of the perimeter rail members to be cut from the same extruded stock. A result, though, is that guide channel 34 is formed in all of the perimeter rails, not just 18 and 20 that support the louvers 14. The guide channel 34 formed in the upper and lower perimeter rails 16 and 18 can be covered, though, by cosmetic cover rails 38A and 38B, as described in greater detail below.

**[0049]** FIG. 7 shows a cross-section of example louver-support rails 36A and 36B, labeled generically as 36. For this example, since the upper and lower perimeter rails 16 and 18 have the same channel 34 as the left and right perimeter rails 20 and 22, the optional cosmetic cover rails 38 have the same cross section as that depicted in FIG. 7.

**[0050]** Referring to FIGS. 6 and 7, it is seen that the guide channel 34 has a cross-section such that the cross-section of louver support rails 36A

and 36B can be inserted at the distal ends of the channel 34, but which constrains the inserted rails 36A and 36B from substantial movement in the plane normal to the extending direction of channel 34. Louver support rails 36A and 36B can therefore be inserted into the channels 34 of the left and right perimeter rails 20 and 22, respectively, during the assembly process, as described below. After assembly, upper and lower perimeter rails 16 and 18 constrain the louver support rails 36A and 36B from movement in the vertical direction, where "vertical" is, in relation to FIG. 1, the direction by which upper and lower perimeter rails 16 and 18 are spaced apart. Referring to FIG. 7, the depicted example louver supports 36A and 36B include a pair of flats 36U that conform to the abutment ridge 34A of the guide channel 34. Although not essential, this option provides additional support for the louver support rails 36A and 36B within the guide channels 34.

**[0051]** With continuing reference to FIG. 1, louver support rails 36A and 36B have a length preferably slightly less than the height D10 defined by the facing inner surfaces of the upper and lower perimeter rails 16 and 18. The length is preferably sufficiently close to D10 to allow assembly while providing adequate securing of the louver support rails against up and down motion.

**[0052]** Referring to FIG. 3, each louver-support rail 36A and 38B has a plurality of louver-support slots 40, each dimensioned to accommodate and support one end of one of the louvers 14.

**[0053]** FIG. 8 is a cross-sectional view of an example louver 14. The relative fit, and kind of securing, if any, between louvers 14 and louver support slots 40 is a design choice. For example, a clearance fit between louver support slots 40 and louvers 14 is contemplated. A clearance fit provides for ready assembly, as described below. Referring to FIGS. 3 and 8, an example clearance fit is achieved by forming slot 40 with the cross-sectional shape as that of louver 14, but approximately .01 inches larger. A clearance fit is only a design choice, and securing louvers 14 to the louver support slots 40 by, for example, welding or adhesive is optional.

**[0054]** Referring to FIGS. 1 and 3, the depicted example shutter 10 has louver-support slots 40 spaced from one another, and angled, to support

louvers 14 in the conventional Bahama shutter style. The specific spacing, and angle, is a design choice, except for the general partial constraint that there must be enough louvers 14, spaced adequately close to one another, so that the shutter provides the desired protection. Further, a general preference is that the spacing and the angle of the louvers 14 are such that some visibility is maintained even when the shutter is closed or otherwise positioned to cover its associated window or portal.

[0055] Referring to FIGS. 2, 3 6, and 7 the optional cosmetic cover rails 38 will be described. As described above, the optional cosmetic cover rails 38, for this example, have the same cross-section as the left and right louver support rails 36A and 36B, which is shown in FIG. 7. The cross section of cosmetic cover rails 38 is the same as the cross section of louver support rails 36A and 36B because, for this example, the upper and lower perimeter rail members 16 and 18 have the same guide channel 34 as the left and right perimeter rail members 20 and 22, but are not required to support the louver support rails. Therefore, similar to the above-described cooperative structure of the louver support rails 36A and 36B in relation to guide channels 34 of the left and right perimeter rails 20 and 22, cosmetic cover rails 38 fit within the guide channel 34 of the upper and lower rails 16 and 18. The cosmetic cover rails are inserted into these guide channels 34 during assembly, as shown by the example assembly process described below. After assembly, the cosmetic cover rails 38 are secured along three axes, in two by their respective guide channels, and in the other by the left and right perimeter rails 20 and 22. Referring to the FIG. 1 example, cosmetic rail covers 38 have a length that is preferably slightly less width D12 defined by the facing inner surfaces of the left and right perimeter rails 20 and 22.

[0056] It will be understood that forming perimeter rails 16, 18, 20 and 22 from the same extruded stock is an example, and not a limitation, on the available structures for the unitary perimeter frame 10 in accordance with the present description. For example, one contemplated alternative is to form each of the perimeter rails 16, 18, 22 and 24 from a solid material, such as nylon, and then drill a round channel similar to the depicted channel 26 into each distal end. The drilled and, hence, round channel

could be used without further forming by, for example, using L-shaped corner connection members similar to the depicted items 24, but having members corresponding to the first and second supporting inserts 24a and 24b with a round, instead of square cross-section. A further alternative would be to swage the drilled channels into a square or rectangular shape, in accordance with the FIG. 6 depicted cross-section for the channels 26.

**[0057]** Another variation is to form the perimeter rails that support louvers, such as rails 20 and 22 of the depicted example, with a cross-section different than rails not directly supporting louvers, such as rails 16 and 18 of the depicted example. Further to such contemplated alternate structures, the cross-section of rails not directly supporting louvers, such as rails 16 and 18 of the depicted example, may be formed to render cosmetic cover rails such as 38 unnecessary.

**[0058]** An example assembly process will now be described. The example process is described as a sequence of manual steps, instead of the automated manufacturing that would likely be used. The sequence of steps is not limiting of the sequences contemplated and, instead, is for purposes of understanding the example structure. The description is according to manual steps so as to provide a ready understanding of the novel features of the present shutter. Automated manufacture, and variations in the ordering of the described steps, in whole or in part, is readily implemented by persons of skill in the relevant industrial arts upon reading this description. The example process uses a common extrusion stock for each of perimeter rails 16, 18, 20 and 22, and a common extrusion stock for louver support rails 38A and 38B and cosmetic cover rails 38.

**[0059]** Referring to FIGS. 1 and 2, an example upper perimeter rail 16, and lower perimeter rail 18, a left perimeter rail 20 and a right perimeter rail 22 are each cut from an extrusion of, for example, aluminum having the FIG. 6 example cross section. The number of louvers 14 is a design choice, with the depicted number being only for purpose of example. Accordingly, two louver support rails 36A and 36B are cut, and a plurality of slots 40 are stamped, or otherwise formed, with each slot having a length and width providing approximately .01" clearance relative to the

thickness and width of the louvers 14. Each of the louvers 14 is cut to a length slightly less than D12 described above. Therefore, such that, when the assembly is complete, one end inserts into a slot 40 in the louver support rail 36A held by the channel 34 of the left perimeter rail 20, and its other end inserts into a slot 40 of the louver support rail 36B in the slot 34 of the right perimeter rail member 22. Cosmetic cover rails 38 are cut from the same extrusion stock as the louver support rails 36A and 36B. Four corner connection members 24 are molded from nylon, each formed generally in accordance with the above-described examples.

**[0060]** Next, a urethane adhesive is applied to one rail engagement member 24A of a first of the four corner connection members 24, and then inserted into the channel at one end of the left perimeter rail 20. Left louver support rail 36A, with a plurality of slots 40 as described above, is then inserted into the U-shaped guide channel 34 of the left perimeter rail 20. Adhesive is then applied to the rail engagement member 24A of a second of the four corner connection members 24, and the insert 24a is then inserted into the other end of the left rail 20. Next, adhesive is applied to the protruding rail engagement member 24A of the first corner connection member 24 secured in the channel 26 at the upper end of the left perimeter rail 20. Likewise, adhesive is applied to the other rail engagement member 24A of the second corner connection member 24 secured in the channel 26 at the lower end of the rail 20. The channel 26 at the left end of the upper perimeter rail 16 is then slid onto that rail extension member 24A at the upper end of the left rail 20. The upper perimeter rail 16 is slid over protruding rail extension member 24A of the corner connection member 24 at the upper end of the rail 20 until the mitered ends of rails 20 and 16 meet. The first corner connection member 24 thereby secures the upper end of the left perimeter 20 rail to the left end of the upper perimeter rail 16, as shown by FIG. 1.

**[0061]** The channel 26 at the left end of the lower perimeter rail 18 is then slid onto the adhesive-covered protruding rail extension member 24A at the lower end of the left perimeter rail 20. The lower perimeter rail 18 is slid over the second supporting insert of the corner connection member at the lower end of the rail 20 until the mitered ends of rails 20 and 18 meet.

The second corner connection member 24 thereby secures the lower end of the left perimeter rail 20 to the left end of the lower perimeter rail 18, as shown by FIG. 1. A partial assembly is now formed, consisting of the left perimeter rail 20, with louver support rail 36A substantially secured in its guide channel 34, the upper perimeter rail 16 and the lower perimeter rail 18.

**[0062]** Next, one cosmetic cover 38 is inserted into channel 34 of the upper perimeter rail 16, and the other cosmetic cover rail 38 is inserted into the channel 34 of the lower perimeter rail 18. Each of the cover rails is inserted until its distal end abuts the left perimeter rail member 20. A urethane adhesive is then applied to one rail engagement member 24A of a third of the four corner connection members 24, which is then inserted into the channel 26 at the upper end of the right perimeter rail 22. Louver support rail 36B, also with slots 40 as described above, is then inserted into the U-shaped guide channel 34 of the right perimeter rail 22. Adhesive is applied to rail engagement member 24A of the fourth corner connection member 24, which is then inserted into the other end of the right perimeter rail 22.

**[0063]** The right perimeter rail 22, with louver support rail 36B in its guide channel 34, can now be attached to the intermediate assembly of the left, upper and lower perimeter rails 20, 16 and 18, to form the unitary frame 10, and securing the nine louvers 14, as shown by FIG. 1. First, adhesive is applied to the protruding other rail engagement member 24A of the third corner connection member 24 secured in the channel 26 at upper end of the right perimeter rail 22. Likewise, adhesive is applied to the protruding other rail engagement member 24A of the fourth corner connection member 24 secured in the channel 26 at the lower end of the rail 22. Next the louvers 14 are inserted into the slots 40 of the louver support rail 36A secured to the left perimeter rail 20, and held in a planar, parallel alignment as shown by FIGS. 1 and 2. The alignment may be assisted by use of an assembly fixture, such fixtures being readily constructed by persons of ordinary skill in the pertinent industrial arts. Next, the protruding rail engagement member 24A of the third corner connection member 24, and the protruding rail engagement member 24A

of the fourth connection member 24 are inserted, respectively, into the left channel 26 of the upper perimeter rail 16 and the lower perimeter rail 18, respectively. The right perimeter rail 22 is then urged toward the left perimeter rail 20, with the louvers 14 aligned with the slots 40 of the right rail's louver support rail 36B. The urging is continued until the mitered upper end of the right perimeter rail 22 contacts the mitered left end of the upper perimeter rail 16, and mitered lower end of rail 22 contacts the mitered left end of rail 18. The assembly is then complete, with the louvers 14 held at each end by the louver support rails 36A and 36B secured by the left perimeter rail 20 and right perimeter rail 22, respectively.

**[0064]** After the adhesive sets the assembly above is a unitary perimeter frame 12 as shown by FIG. 1.

**[0065]** FIG. 9 is a cut-away front view of a latch mechanism 44 that utilizes one of the corner connection members 24 as a latch-supporting guide. The FIG. 9 example shows the latch mechanism 44 at the lower right of the FIG. 1 example, which is the junction of the lower perimeter rail 18 and the right perimeter rail 22. This is not limiting, as the FIG. 9 latch can be formed at any one or more corners of the frame 12, utilizing any of the corner connection members 24.

**[0066]** Referring to FIG. 9, the latch mechanism 44 comprises a latch pin 46, a thumbscrew 48 having a threaded shaft 52, and a latch pin receiver 54. The latch pin 46 passes through a clearance hole 54 formed in the corner connection member 24. The clearance hole 54 may be drilled through a standard-form corner connection member 24 or, for example, only certain of the corner connection members may be molded having the hole 54. A slot having a width slightly larger than the diameter of the threaded shaft 50 of the thumbscrew 48 is formed through the bottom wall of the perimeter rail 18, having a length allowing the latch pin 46 to extend into the latch pin receiver 54, for locking the shutter, while allowing the latch pin 46 to be retracted from the latch pin receiver 54, to release the shutter.

**[0067]** FIG. 10 is a perspective view of an example latch pin receiver 54, formed as a camel bracket having a through hole 58 in one of its two

side plates 60. The through hole 58 is slightly larger than the latch pin 46, to provide clearance but not so large as to promote excessive movement normal to the pin axis. Referring again to FIG. 9, the latch pin 46 has a tapered end 46A, which allows the pin 46 to seek the through hole 58 when actuated into a locking position, as described below. The latch pin receiver 50 is mounted using, for example, two screws 56 to, for example, an exterior of a building adjacent to a window.

**[0068]** FIGS. 11 to 16 show a further shutter 11 employing a unitary perimeter frame such as described in reference to FIG. 1, further including a center support for the louvers. Referring to FIG. 11, which is a front projection of the shutter 11, the depicted shutter comprises a unitary frame 80, a center louver-support member 82, a plurality of one-piece louvers 84, a top two-piece louver, with its parts labeled 86A and 86B, and a bottom two-piece louver, with its parts labeled louver 88A and 88B. The unitary frame 80 is, for this example, substantially identical to the FIG. 1 unitary frame 12 of shutter 10 and, accordingly, like members will be numbered in the same manner as FIGS. 1-8.

**[0069]** FIG. 12 shows the FIG. 11 shutter with its upper perimeter rail 16 removed, and center lateral securing member 90 suspended above its insertion position, which is described further below. FIG. 13 shows a perspective view of the I-frame 92 of the center louver-support member 82, and FIG. 14 shows the end view of the I-frame 92, having left center louver support rail 94A and right center louver support rail 94B inserted. Referring to FIG. 14, the I-frame 92 has a center wall 96 and four flanges 98. Ridges 98A, 98B, 98C, 98D, 98E, 98F, 98G and 98H extend the length of the I-frame 84. Ridges 98A, 98B, 98C, 98D are constructed and arranged to constrain the left center louver-support rail 94A from substantial movement normal to the extending direction of member 82. Likewise, ridges 98E, 98F, 98G and 98H are constructed and arranged to constrain the right center louver-support rail 94B from substantial movement normal to the extending direction of member 82.

**[0070]** For this example, the left and right center louver support rails 94A and 94B are structured identical, respectively, to the left and right louver support rails 36A and 36B. As described above, the left and right

louver support rails 36A and 36B are inserted into and constrained by the guide channel 34 formed on the left and right perimeter rails 20 and 22, respectively. Accordingly, using FIG. 7 as an example cross-section for the left and right louver support rails 36A and 36B, the left and right center louver support rails 94A and 94B each have the FIG. 7 cross-section. Therefore, ridges 98A, 98B, 98C and 98D, and ridges 98E, 98F, 98G and 98H each define a channel (not labeled) substantively identical to the guide channel 34 formed on the outer perimeter rail members 16, 18, 20 and 22.

**[0071]** Referring to FIG. 13, the center wall 96 of the I-frame 92 has a plurality of clearance holes 100 shaped in accordance with the cross-section of the one-piece louvers 84. Since the frame 80 is in accordance with the frame 10 of FIG. 1, the clearance holes 100 are identically shaped, spaced and angled as the clearance holes 40 formed in the left and right louver-support rails 36A and 36B. Likewise, each of the left and right center louver-support rails 94A and 94B has a plurality of clearance holes 100, identically shaped, spaced and angled as the clearance holes 40 formed in the left and right louver-support rails 36A and 36B.

**[0072]** FIG. 15 shows the shutter 80 of FIG. 11 with its upper perimeter rail 16 suspended above its assembly position, showing the tongs 90A that insert into the space 104 visible in FIG. 12. Slot 90B provides clearance for the center wall 94 of the I-frame 92. FIG. 16 is a partial cut-away of the top perimeter rail member, in its assembled position reflected in FIG. 11, showing the upper portion 90C of the center lateral support member 90 inserted into the channel 34 of the upper perimeter rail 16.

**[0073]** Referring to FIG. 16, instead of a one-piece cosmetic cover rail 38 as described in reference to FIGS. 1, two lateral support rails are inserted into the channel guide 34 of the upper perimeter rail 16, the left labeled as 106A, the right labeled as 106B. For this example, the lateral support rails 106A and 106B have the same cross section as rails 36A, 36B and 38, thereby utilizing the fact that perimeter rails 16, 18, 20 and 22, for this example, have the same cross section and, hence, the guide same channel 34.

**[0074]** With continuing reference to FIG. 16, the left distal end of left lateral support rail 106A abuts against the upper left of the left perimeter

frame member 16. Likewise the right distal end of right lateral support rail 106B abuts against the upper left of the right perimeter frame member 16.

**[0075]** A structure identical to the example described in reference to FIG. 16 is formed at the lower end of the center louver-support member 82, with another center lateral support member 90 having a portion 90C between another pair of lateral support rails 106A and 106B within the channel 34 of the lower perimeter rail 18.

**[0076]** Referring to FIG. 12, it is seen that the outer distal end of the left upper louver 86A extends through the upper hole 40 in the left louver support rail 36A, and abuts against the bottom 34A of channel 34 formed on the left perimeter rail 16. The inner distal end of the left upper louver 86A extends through the upper hole 100 in the left center louver support rail 94A, but does not extend all the way to the center wall 96. Similarly, the outer distal end of the right upper louver 86B extends through the upper hole 40 in the right louver support rail 36B, and abuts against the bottom 34A of channel 34 formed on the right perimeter rail 18. The inner distal end of the right upper louver 86B extends through the upper hole 100 in the right center louver support rail 94B but, like the inner distal end of louver 86A, does not extend all the way to the center wall 96. The spacing between the inner distal ends of the upper left louver 86A and upper right louver 86B, with their respective outer distal ends against the left and right perimeter rails 20 and 22, is slightly larger than the width WD of the center support member 90. When the upper perimeter rail 16 is installed as shown in FIGS. 11 and 16, the channel 90B allows the tongs 90A to extend along center wall 96 of the I-frame 92. The tongs 90A, and the left and right perimeter rails 20 and 22, thereby support the left and right upper louvers 84A and 84B from substantial lateral movement.

**[0077]** The lower left louver 88A and lower right louver 88B are supported by a center support member identical to item 90, in the manner described above for the upper left and right louvers 86A and 86B.

**[0078]** Referring to FIGS. 11 – 16, each of the louvers 84 is a one-piece structure, having its left distal end extending through a corresponding hole 40 in the left louver support rail 36A, its center region extending through aligned respective holes in the left center louver support

rail 94A, the center wall 96 of the I-frame 92, and the right center louver support rail 94B, and its right distal end extending through a corresponding hole 40 in the right louver support rail 36B.

**[0079]** The described structure provides for all, or for most of the louvers to be one-piece, and to be further supported in the center by member 82. The unitary perimeter frame 80 has the same construction as the unitary perimeter frame 12 of FIG. 1, comprising perimeter rails 16, 18, 20 and 22, assembled into a unitary structure by four corner members 24, as described above. The unitary perimeter frame 80 supports a plurality of one-piece louvers 84, a top two-piece louver, with its parts labeled 86A and 86B, and a bottom two-piece louver, with its parts labeled louver 88A and 88B. This increases the strength of the louvers 84 with respect to airborne objects. The above-described center louver-support member 82, formed of the I-frame 92 and center louver-support rails 94A and 94B, is only for purposes of example. Various alternative structures, however, are contemplated. One alternative is to form all of the louvers as one-piece, such as items 84. This may be done, for example, by using a lateral securing member similar to item 90 but, instead of having tongs 90A, having a structure that can insert into the space corresponding to space 104 that would remain if louvers 86A and 96B were formed as one piece and extended through the center wall 96.

**[0080]** Shutters in accordance with the above-described structures provide superior protection and durability, relative to prior art shutters having perimeter frames screwed or welded together. For example, the rail engagement members 24A extend into the channels 26 a distance of, for example, approximately two to three inches, and are preferably secured therein with adhesives, which distributes the torque and flexing forces at the frame joints over a much larger area than obtained with welded or screwed abutments. Further, by using corner connection members 24 of, for example, nylon, the corner connection members can flex when the shutter is subjected to severe wind and flying object forces, which reduces the bending and twisting forces applied to the abutting ends of the perimeter rail members, as compared to prior art welds and screw connection. Still further, the connections provided by the cooperative fit of

the corner connection members 24 and the channels 26 of the perimeter rail members 16, 18, 20 and 22 avoid heat effects, and associated weakening, often resulting from welding methods of the prior art.

**[0081]** The above-described shutters can be installed onto buildings using any known attachment method, including a conventional hinge arrangement. FIG. 17 shows an adaptation of a conventional hinge to the above-described extruded perimeter rail members, having a hinge member 110. The hinge member 110 may be extruded to extend the entire length of perimeter rail members. Another example hinge in shown by FIG. 18, which is a plate 112 having a hinge member 114 similar to 110, with the plate 112 being screwed or otherwise attached to a perimeter rail.

**[0082]** Those skilled in the arts pertaining to the above-described shutter structures and methods understand that the preferred embodiments described above may be modified, without departing from the true scope and spirit of the description and claims, and that the particular embodiments shown in the drawings and described within this specification are for purposes of example and should not be construed to limit the claims below.